Einstein's anomalous clock synchronisation

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ABSTRACT

Einstein's method of synchronising clocks in his Special Theory of Relativity is inconsistent with the Lorentz Transformation.

1 Introduction

It has recently been proven by Engelhardt [1] that Einstein's method of synchronising clocks in his Special Theory of Relativity is inconsistent with the Lorentz Transformation. Although Engelhardt's proof is definitive, it can be extended to show that for any time $t > 0$ in Einstein's 'stationary system' there is always a place ξ in Einstein's 'moving system' where the time τ therein is zero, despite t and τ being synchronised according to Einstein's method.

In §1 of his 1905 paper, Einstein [2] defined the 'common time' for the points A and B in a space:

> "*We have so far defined only an 'A time' and a 'B time.' We have not defined a common 'time' for A and B, for the latter cannot be defined at all unless we establish* by definition *that the 'time' required by light to travel from A to B equals the 'time' it requires to travel from B to A. Let a ray of light start at the 'A time'* t_A *from A towards B, let it at the 'B time'* t_B *be reflected at B in the direction of A, and arrive again at A at the 'A time'* t'_A.
>
> "*In accordance with definition the two clocks synchronize if*
>
> $$t_B - t_A = t'_A - t_B."$$

Einstein [2, §3] then produced the Lorentz Transformation:

$$\begin{aligned} &\tau = \beta\left(t - vx/c^2\right), \quad &&\xi = \beta\left(x - vt\right), \\ &\eta = y, &&\zeta = z, \\ &\beta = 1/\sqrt{1 - v^2/c^2} && \end{aligned} \tag{1}$$

where x, y, z, t, pertain to the 'stationary system' and v is the uniform rectilinear speed between the two systems of coordinates in the direction of the positive x-axis.

2 Einstein's inconsistency

First, Einstein [2, §3] synchronised his clocks for both his 'stationary system K' and his 'moving system k':

> "*... let the time t of the stationary system be determined for all points thereof at which there are clocks by means of light signals in the manner indicated in §1 ; similarly let the time* τ *of the moving system be determined for all points of the moving system at which there are clocks at rest relatively to that system by applying the method, given in §1, of light signals between the points at which the latter clocks are located.*
>
> "*To any system of values* x, y, z, t, *which completely defines the place and time of an event in the stationary system, there belongs a system of values* ξ, η, ζ, τ, *determining that event relatively to the system k*".

Thus, for any given 'event', by his sychronisation method, all points in Einstein's 'stationary system K' have the common time t and all points in his 'moving system k' have the common time τ.

Einstein [2, §3] then superposed his two coordinate systems so that their origins coincide and time in both systems is reckoned from zero, as illustrated in figure 1.

> "*At the time* $t = \tau = 0$, *when the origin of the co-ordinates is common to the two systems, let a spherical wave be emitted therefrom, and be propagated with the velocity c in system K.*"

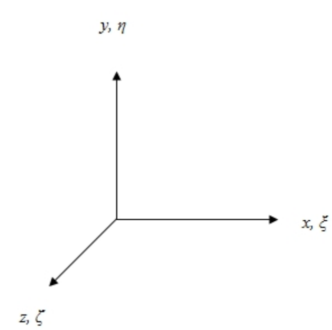

Fig. 1: Initial conditions

After a time $t > 0$, $\tau > 0$, and the 'moving system k' has advanced in the direction of the positive x-axis, illustrated in figure 2.

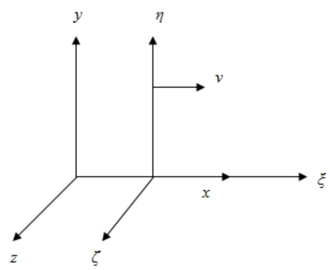

Fig. 2: Subsequent conditions

According to the Lorentz Transformation Eqs.(1), the time τ is a function of both x and t when $v \neq 0$. Elimination of x for the 'stationary system K' in Eqs.(1) yields,

$$\tau = \frac{t}{\beta} - \frac{\xi v}{c^2} \tag{2}$$

If $\xi = 0$, then,

$$\tau = t/\beta \tag{3}$$

and so when $t = 0$, $\tau = 0$ too. Eq.(3) is Einstein's 'time dilation'. However, as Engelhardt [1, §3] correctly observes, according to Eq.(2), when $t = 0$,

$$\tau = -\frac{\xi v}{c^2} \tag{4}$$

which is not in accord with Einstein's synchronisation method because the time τ differs with position ξ. To amplify, set $\tau = 0$. Hence,

$$0 = \frac{t}{\beta} - \frac{\xi v}{c^2} \tag{5}$$

which yields,

$$\xi = \frac{tc^2}{\beta v} \tag{6}$$

Thus, for every $t > 0$ of the 'stationary system K' there exists a point $\xi \neq 0$ in the 'moving system k' where $\tau = 0$. However, according to Einstein's synchronisation method this is impossible. Einstein's synchronisation method is inconsistent with the Lorentz Transformation.

3 Einstein's 'time'

Einstein [2, §1] defined time by means of his clocks. However, time is no more defined by a clock than pressure is defined by a pressure gauge, speed by a speedometer, heat by a thermometer, or gravity by a spring. Measuring instruments are invented to measure something other than themselves. Einstein's clocks measure only themselves.

References

[1] Engelhardt, W., Einstein's third postulate, *PHYSICS ESSAYS*, **29**, 4 (2016)

[2] Einstein, A., On the electrodynamics of moving bodies, *Annalen der Physik*, 17, 1905